Interdigitated silicon CRLs: A route to full-field hard x-ray microscopy

Hugh Simons[a,b], *Frederik Stöhr*[c], *Jonas Michael-Lindhard*[c], *Flemming Jensen*[c], *Ole Hansen*[d,e], *Carsten Detlefs*[b], *Henning Friis Poulsen*[a]

[a] *Department of Physics, Technical University of Denmark, Kgs. Lyngby 2800, Denmark,*
[b] *European Synchrotron Radiation Facility, Grenoble 38000, France*
[c] *DANCHIP, Technical University of Denmark, Kgs. Lyngby 2800, Denmark*
[d] *DTU Nanotech, Technical University of Denmark, Kgs. Lyngby 2800, Denmark*
[e] *CINF, Technical University of Denmark, Kgs. Lyngby 2800, Denmark*

Author Email: husimo@fysik.dtu.dk

Full-field x-ray microscopy using x-ray objectives has become mainstay of the biological and materials sciences. However, the inefficiency of existing high-resolution objectives at x-ray energies above 15 keV has limited the technique to weakly absorbing or two- dimensional (2D) samples. Here, we show that imaging objectives with significant numerical aperture and spatial resolution may be possible at hard x-ray energies by using silicon-based optics comprising 'interdigitated' refractive silicon lenslets. To achieve the 2D focusing condition, the interdigitated lenslets alternate their focus between the horizontal and vertical directions (Fig. 1a). By capitalizing on the nano-manufacturing processes available to silicon, we show that it is possible to make powerful, miniaturized imaging CRLs that minimize the inherent inefficiencies of silicon-based optics and interdigitated geometries. As a proof-of-concept of Si-based interdigitated objectives, we demonstrate a prototype interdigitated lens with a resolution of ≈ 255 nm at 17 keV (Fig 1b).[1]

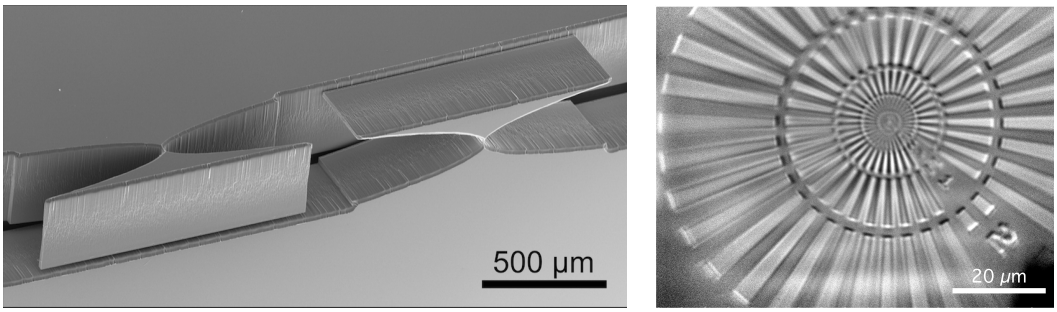

Fig 1. (a) SEM image of the prototype interdigitated 2D silicon lenslet. (b) Image of resolution test chart recorded using the lens in (a) at an energy of 17 keV and magnification of 11.

References

[1] H. Simons, F. Stöhr, J. Michael-Lindard, F. Jensen, O. Hansen, C. Detlefs and H.F. Poulsen, *"Full-field hard x-ray microscopy with interdigitated silicon lenses"*, Submitted (2015)